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Individual Differences and Learning Performance in Computer-based Training

Rosemary A. Schultz, Ph.D.
David L. Alderton, Ph.D.
Andrea Bordwell Hyneman



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Reviewed, Approved, and Released by
David M. Cashbaugh
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14. ABSTRACT This work is in support of a multi-year project to evaluate "people-centered" aspects of computer-based training (CBT) or technology assisted instruction. The core component of the work will be developing a longitudinal database that will include individual difference measures of non-cognitive characteristics (e.g., personality, temperament, interests) of students, student engagement and satisfaction with instruction, student outcomes, and early job satisfaction and performance. This report is a selected literature review to provide a starting point from which to view the interaction between individual differences in non-cognitive characteristics, instructional methods, and learning outcomes to inform decisions on which non-cognitive characteristics to use in the research. Two-hundred and thirty-five research and theoretical articles, book chapters, and reports were reviewed. Dozens of non-cognitive characteristics and their association with learning outcomes were scrutinized, with a special emphasis on those associated with computer-based training. Eight categories of individual difference constructs were found to be important predictors of outcomes. motivation to learn; intrinsic motivation; metacognitive abilities; goal orientation; personal control beliefs; personality measures (e.g., conscientiousness, flexibility, emotional control); organizational commitment and perceptions of fairness; and attitudes towards training. While the results were not predetermined, following the review of critical non-cognitive characteristics, the recommendation is to utilize a Navy-developed battery of personality traits referred to as the Navy Computer Adaptive Personality Scales (NCAPS) because it's 19 traits cover the characteristics that should be measured, the battery is owned by the Navy and is not proprietary, has proven to be fake resistant, has been evaluated many Navy personnel, and it is web-enabled which reduces barriers to administration.					
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Foreword

This work is in support of a multi-year project to evaluate “people-centered” aspects of computer-based training (CBT) or technology assisted instruction. One component of this project will identify the prior experience new recruits have with technology assisted instruction and computer-based training. The core component of the work will be developing a longitudinal database that will include individual difference¹ measures of non-cognitive characteristics (e.g., personality, temperament, interests) of students, student engagement and satisfaction with instruction, student outcomes, and early job satisfaction and performance. Initial technical training pipelines will be chosen that vary in length, complexity, and instructional methods (e.g., primarily CBT, instructor-led, and blended methods) to evaluate interactions between student non-cognitive characteristics and learning outcomes. This report is a selected literature review to provide a starting point from which to view the interaction between individual differences in non-cognitive characteristics, instructional methods, and learning outcomes to inform decisions on which non-cognitive characteristics to use in the research. While the results were not predetermined, following the review of critical non-cognitive characteristics, the recommendation is to utilize a Navy-developed battery of personality traits referred to as the Navy Computer Adaptive Personality Scales (NCAPS) because it covers the characteristics that should be measured, the battery is owned by the Navy and is not proprietary (avoiding short and long term costs), the test has proven to be fake resistant, has been evaluated on over 25,000 Navy personnel, and it is web-enabled which reduces barriers to administration.

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David M. Cashbaugh
Director

¹ The term “individual differences” refers to the field of study called differential psychology. This field focuses on how individuals (or groups of individuals) differ from one another; for example, in height, simple reaction time, auditory acuity, topical knowledge, intelligence, personality traits, interests, and attitudes. Typically, some measurement of a construct is developed (e.g., a mechanical knowledge test), administered to people, and the dispersion of scores (“differentials”) is observed and scrutinized. “Individual differences” then refers to measures that differentiate one individual from another on a specific measure. The subfield of individual differences that focuses on the science of measurement properties that underlie formal tests (e.g., SAT, ACT) is called psychometrics. In the current context, “individual differences” will refer to measures of constructs that differentiate (or scale) people relative to one another.

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Overview

The purpose of this literature review is to identify individual differences (e.g., motivation, personality traits, self-concept, interests, etc.) that are likely to predict and explain training performance in Navy classrooms and which may interact with various instructional methods (e.g., self-paced, computer-based training [CBT], instructor-led, computer-assisted and instructor-led blended training, etc.). Training theory and research widely recognizes that motivation to learn has a direct effect on learning outcomes. In addition, individual characteristics and situational factors are also recognized as having direct and indirect effects on motivation to learn and learning outcomes (Colquitt, LePine, & Noe, 2000). Not only will individual characteristics have a direct affect on learning performance and outcome measures, but they can interact with the delivery method of training to change the way trainees respond to training (Gully & Chen, 2010; Salas, Kosarzycki, Burke, Fiore, & Stone, 2002).

How Individual Differences Impact Training Outcomes

Gully and Chen (2010) suggest that individual differences have an impact on learning performance through four intervening mechanisms: (a) information-processing capacity, (b) attentional focus and metacognitive processing, (c) motivation and effort allocation, and (d) emotional regulation and control. Information-processing capacity includes general cognitive ability, fluid and crystallized intelligence,² and working memory³ capacity. Attentional focus and metacognitive processing includes cognitive resources related to the learning task or to the situation. Metacognition has been described as “thinking about your thinking.” These abilities are required to develop plans and to evaluate progress, and therefore, are critical for learning to occur (Flavell, 1979). Motivation and effort allocation includes general motivation (motivation to learn), as well as more specific motives such as learning goal orientation. Emotional regulation and control refers to the processes involved in controlling negative emotional reactions (e.g., anxiety and frustration) and the generation of positive facilitative emotions during training.

Many of Gully and Chen’s (2010) intervening mechanisms can be considered as part of the self-regulatory system. Self-regulation is a collection of abilities and processes that help individuals to stay focused on a task, to monitor their own progress in completing that task, and to control their thoughts, feelings, and behaviors. Self-regulation also includes metacognitive abilities, including memory, attention, and goal

² Fluid and crystallized intelligence (abbreviated G_f and G_c , respectively) are facets of general intelligence originally identified by Raymond Cattell (1971). Fluid intelligence or fluid reasoning is the capacity to think logically and solve problems in novel situations, independent of acquired knowledge. Crystallized intelligence is the ability to use skills, knowledge, and experience; it should not be equated with memory or knowledge, but it does rely on accessing information from long-term memory.

³ Working memory is the limited capacity ability to actively hold information in consciousness that is needed to perform complex tasks such as reasoning, comprehension and learning. Working memory tasks are those that require the goal orientated active monitoring or manipulation of information.

setting for problem solution. This enables learners to make the best use of their knowledge, time, and skills (Pressley, 1995).

Self-regulatory theories have proven relevant to various lines of research, including metacognition, achievement goals, intrinsic motivation, action control, appraisal (or evaluation) processes, autonomy and self-determination in goal-setting, and cognitive or metacognitive strategic use in the implementation of goals (Efklides, Niemivirta, & Yamauchi, 2002), including learning (Bandura, 1991; Bell & Kozlowski, 2002a; Boekaerts, Pintrich, & Zeidner, 2000; Flavell, 1979; Keith & Frese, 2005; Kraiger & Jerden, 2007; Santhanam, Sasidharan, & Webster, 2008; Sitzman, Bell, DeRouin, Fritzsche, & Salas, 2005; Sitzmann, Bell, Kraiger, & Kanar, 2009; Sitzmann, Kraiger, Stewart, & Wisher, 2006). Self-regulated learning models attempt to integrate cognitive, affective-motivational, and behavioral aspects of learning (Boekaerts et al., 2000). Self-regulated learning models are advantageous in learning research because they allow researchers to describe the many levels and processes involved in successful learning outcomes, to explain reciprocal and recurrent relationships established between these components, and to directly relate learning with goals, motivation, and emotions (Boekaerts, 1999).

Self-regulated learning includes processes such as:
setting goals for learning, attending to and concentrating on instruction, using effective strategies to organise, code and rehearse information to be remembered, establishing a productive work environment, using resources effectively, monitoring performance, managing time effectively, seeking assistance when needed, holding positive beliefs about one's capabilities, the value of learning, the factors influencing learning and the anticipated outcomes of actions, and experiencing pride and satisfaction with one's efforts (Schunk & Ertmer, 2000, pp. 631).

In order to self-regulate, trainees must engage in both emotional control and metacognition (Kanfer, 1996; Kanfer & Ackerman, 1996), both of which have direct effects on learning (Keith & Frese, 2005). Emotional control limits the impact of negative affect (e.g., anxiety or worry) during learning while metacognitive ability involves controlling one's cognitions, planning, monitoring, and evaluating one's progress during task execution (Kanfer & Ackerman, 1989). There has not been as much research on other self-regulation processes (e.g., motivational and emotional regulation) on learning as there has been on metacognitive ability, but researchers have recently taken note and begun to recognize their impact (Pintrich, 2000).

Metacognitive abilities are involved in decisions about how personal resources are allocated during training, in monitoring and controlling resources to keep them on on-task activities rather than off-task activities, and in making changes in resource and effort allocations during training (Kanfer & Ackerman, 1989). Often deficiencies in performance can be explained by inaccurate self-assessments of current knowledge levels, deficits in the amount of effort allocated to the task, or poor decisions during training (Brown, 2001; Kanfer & Ackerman, 1989; Sitzmann, Ely, Brown, & Bauer, 2010). Social-cognitive models of self-regulated learning include self-concepts, motivational feelings and beliefs, as well as learning strategies and metacognitive skills

(i.e., the knowledge and control that individuals have over their own thinking processes) (Zimmerman, 1995).

Because computer-based training (CBT) tends to provide trainees with more opportunities to have control over their learning experience than traditional classroom instruction (Sitzmann et al., 2006), using self-regulation theories will prove useful as an organizational framework for looking at how individual differences influence CBT learning outcomes and success. Indeed, research suggests that trainees' poor ability to self-regulate is why some trainees fail to complete or succeed in training when using CBT (Bell & Kozlowski, 2002a; DeRouin, Fritzsche, & Salas, 2005; Kraiger & Jerden, 2007).

Individual Differences that Affect Training Outcomes

Metacognitive Abilities (MCA)

Individual differences can affect learning performance in MCA; fortunately, MCA is itself an individual difference construct that is often measured. While metacognitive knowledge is comprised of several components, the research and theoretical focus on MCA typically focuses on two components, monitoring and control. Metacognitive monitoring skills include evaluating learning progress and predicting outcomes, whereas metacognitive control includes decisions on where to allocate effort and resources. Some models of self-regulated learning have posited metacognitive monitoring as the key to self-regulated learning (Butler & Winne, 1995; Winne, 1996, 1997). Self-monitoring skills contribute to the ability to know how well one is performing, when one is likely to be accurate in judgment, and when one is likely to be in error (Chi, Glaser, & Rees, 1982). These skills are essentially declarative knowledge⁴ about the interactions between person, task, and strategic characteristics (Flavell, 1979). Metacognitive knowledge refers to procedural knowledge⁵ for regulating problem solving and learning activities, which can be correct or incorrect (Brown & DeLoache, 1978; Veenman & Spaans, 2005).

Some researchers consider self-regulation to be a precursor to metacognition (e.g., Brown & DeLoache, 1978; Kluwe, 1987), whereas others regard metacognition as a precursor to self-regulation (e.g., Winne, 1996; Zimmerman, 1995). According to the latter social-cognitive perspective, self-regulation also involves motivational and social-emotional processes. Of particular interest, the majority of research looking at the influence of MCA on learning performance has been conducted in CBT environments (Gully & Chen, 2010). Learning performance in these situations is considered to be

⁴ "Declarative knowledge" is factual, descriptive, or propositional information. For example, knowledge of what a bicycle is (in contrast to knowledge of how to ride a bike). Shorthand mnemonic: knowing what (vs. knowing how).

⁵ "Procedural knowledge" is process or procedural information. For example, knowledge of riding a bicycle (in contrast to knowledge of what a bicycle is). Shorthand mnemonic: knowing how (vs. knowing what).

more affected by MCA because the absence of a face-to-face instructor increases the need for individual learner control.

MCA is a component in several models of intelligence. Brown (1987) saw conscience MCA as a characteristic of high intelligence. Sternberg's Triarchic Theory of Human Intelligence refers to "metacomponents" that control other cognitive components as well as receive feedback from these components in a feedback loop necessary for learning (Sternberg, 1984, 1986a, 1986b). However, Sternberg (1990) later maintained that metacognitive skills cannot be equated with intellectual ability. Many studies have shown that metacognitive skills, although moderately correlated to intelligence, contribute to learning performance on top of intellectual ability. For instance, metacognitive skills outweighed intelligence in predicting learning performance in one study of secondary students (Veenman & Spaans, 2005) but intellectual ability was still critical. In another study, intellectual ability uniquely accounted for 10 percent of variance in learning on average, while metacognitive skills uniquely accounted for 17 percent of variance in learning, and both predictors shared another 20 percent of variance in learning (Veenman, Van Hout-Wolters, & Afflerbach, 2006; Veenman & Spaans, 2005). The implication is that an adequate level of metacognition may compensate for trainees' cognitive limitations, at least up to some minimal threshold.⁶

Measurement of MCA can be based on actual behaviors and performance during training, think-aloud reports in which individuals describe their thinking while it is occurring, retrospective interviews in which people recall what they had been thinking, or self-report measures. State and trait⁷ versions of the self-report measures have been used to measuring MCA, with trait MCA influencing state MCA (Goos, Galbraith, & Renshaw, 2000; Hong & O'Neil, 2001; O'Neil & Abedi, 1996; Schraw & Dennison, 1994; Tobias & Everson, 1997).

Metacognitive skills initially develop in separate domains of knowledge, and later become generalized across domains (Veenman & Spaans, 2005). MCA may be trainable and amenable to training design factors (Bell & Koslowski, 2002a, 2002b, 2008; Dunlosky, Kubat-Silman, & Hertzog, 2003; Keith & Frese, 2005; Schmidt & Ford, 2003). Metacognitive skills can be trained via computer-based training with metacognitive instructions before a learning activity (Schmidt & Ford, 2003) or embedded within the learning activity (Alevan & Koedinger, 2002).

Motivation

⁶ MCA and these results derive from mainstream psychology and education literatures. More sophisticated and subtle distinctions are made in the cognitive neuropsychological literature. Here, the components of what are referred to as metacognitive monitoring and control, are called executive functions (EF) but serve similar purposes in support of learning and intelligence. Examples of primary executive functions include "inhibiting" prepotent responses, "shifting" mental sets, and "updating" working memory. Even still, this literature on executive functions, with both normal and frontal lobe damaged populations, have found that executive functions are critical to learning and intelligence. Moreover, the evidence is that there is only a modest degree of overlap between the executive functions. See for example, Friedman et al. (2006) and Salthouse, Atkinson, & Berish (2003).

⁷ "State" refers to a transitory characteristic of an individual whereas "trait" refers to an enduring response proclivity. For example, there is "state anxiety" which refers to the anxiety that a person is currently experiencing and is in contrast to "trait anxiety" which refers to the tendency of a person to generally experience anxiety (or not).

Motivation to Learn

Trainee characteristics have been found to have a wide influence on learning and training outcomes, mainly through their effect on motivation to learn (Thayer & Goldstein, 2010). Motivation to learn has been defined as a malleable individual characteristic that affects the willingness, direction, intensity, and persistence of learning-directed behavior and also influences the choices individuals make during learning activities (Noe, 1986; Noe & Schmitt, 1986). Several studies show that it is positively related to learning and is, in fact, a critical precursor (Baldwin, Magjuka, & Loher, 1991; Campbell, 1989; Colquitt et al, 2000; Colquitt & Simmering, 1998; Gist, Stevens, & Bavetta, 1991; Goldstein, 1993; Mathieu, Tannenbaum, & Salas, 1992; Martocchio & Webster, 1992; Noe, 1986; Noe & Schmitt, 1986; Quiñones, 1995; Tannenbaum, Mathieu, Salas, & Cannon-Bowers, 1991). Trainees who are motivated to learn are more likely to engage in learning activities they believe are beneficial. They pay more attention during class, study harder, and are more likely to request help when they need it (Pintrich & Garcia, 1991). The effects of other individual characteristics on motivation to learn will be referred to throughout this review.

Intrinsic Motivation

Research by Deci, Ryan, and associates (e.g., Deci, Connell, & Ryan, 1989; Deci, Koestner, & Ryan, 1999; Deci & Moller, 2005) has shown that motives can be classified as intrinsic or extrinsic. Individuals are thought to be internally motivated if they find the task rewarding from the experience, pleasure, and satisfaction inherent in the activity. In contrast, individuals are externally motivated if they participate in the task as a means to obtain rewards that are not directly part of the task, for example, money or praise. Compared to extrinsically motivated trainees, intrinsically motivated trainees usually have better training performance, enjoy the training more, are more curious about the topic, and engage in deeper levels of learning (Deci & Ryan, 2000). Intrinsically motivated trainees are more likely to have a learning goal orientation during training (Harackiewicz & Elliot, 1993; Pintrich & de Groot, 1990). Students with greater intrinsic motivation who also view the learning activity as important, are also more likely to use adaptive self-regulatory strategies (Schunk, 2005)

Career Interests

Although there is not a lot of research in the area of the effects of career interests on training performance, Gully and Chen (2010) point out that individuals who are interested in and have a vocational aptitude for a particular career should be more likely to maintain motivation and attentional focus in training relevant to their career, based upon the observed overlap between personality, ability, and interests (c.f., Ackerman & Heggstad, 1997; Barak, 2001). They expect that vocational interests will have similar effects as personality and other interests, although the effect of interests may be more pronounced when trainees are positively affected by the training material because they should process content more effectively and perhaps more deeply as well.

Goal Orientation/Achievement Goals

A goal orientation is a cognitive representation of a goal that the trainee establishes during learning. Initial research on goal orientation (e.g., Dweck, 1986; Eison, 1981; Nicholls, 1975) compared learning goal orientation (LGO, also known as mastery goal orientation) with performance goal orientation (PGO, also known as achievement goal orientation). A trainee with a learning goal orientation (LGO) wants to increase his or her competence and research generally shows that these trainees tend to learn more from experimentation and failure since they are testing their knowledge against self-referenced standards (e.g., doing better than they did the last time they attempted the learning task). In contrast, a trainee with a performance goal orientation is more focused on demonstrating high ability on the task and these trainees tend to be more concerned about getting a positive evaluation and outperforming others while showing less effort.

Trainees with higher LGO have been shown to reach greater levels of learning, knowledge development, skill acquisition, and performance (e.g., Bell & Kozlowski, 2002b). A number of research findings may shed light on this relationship. LGO is positively related to feedback-seeking behavior (VandeWalle & Cummings, 1997; VandeWalle, Ganesan, Challagalla, & Brown, 2000), having more complex learning strategies (Ames, 1992; Fisher & Ford, 1998; Payne, Youngcourt, & Beaubien, 2007), and adaptive performance (Kozlowski et al., 2001). LGO is also positively related to self-efficacy (Bell & Kozlowski, 2002b; Kozlowski, Gully, et al, 2001; Phillips & Gully, 1997; Potosky & Ramakrishna, 2002), enjoyment of the activities (Barron & Harackiewicz, 2001), and motivation to learn (Colquitt & Simmering, 1998). Higher LGO trainees tend to react more positively to learning opportunities, choose more challenging tasks, persist in the tasks they choose (Farr, Hofmann, & Ringenbach, 1993; Phillips & Gully, 1997), and tend to remain motivated in the face of performance difficulties (Colquitt & Simmering, 1998), perhaps because they use self-regulation strategies to maintain their interest and motivation for the learning task (Zimmerman & Martinez-Ponz, 1990). They use metacognitive strategies more than high PGO trainees (Ford, Smith, Weissbein, Gully, & Salas, 1998) and tend to set advanced or stretch goals (Brett & VandeWalle, 1999; Phillips & Gully, 1997). LGO is not, however, always beneficial; Bell and Kozlowski (2002b) found that trainees' general cognitive ability influenced the effectiveness of LGO. High ability trainees can benefit from LGO and tend to show increases in self-efficacy and in learning performance; however, lower ability trainees with high LGO experienced deficits in both self-efficacy and learning performance.

Higher PGO trainees tend to have lower motivation to learn (Colquitt & Simmering, 1998) and show more anxiety during training (Chen, Gully, Whiteman, & Kilcullen, 2000). They tend to choose tasks they perceive to be easier and more likely achievable (Phillips & Gully, 1997). Some research shows a negative relation of PGO with self-efficacy (Payne et al., 2007; Phillips & Gully, 1997) and a hesitance to seek feedback, especially when higher PGO trainees are also high in performance avoidance orientation (Payne et al., 2007; VandeWalle & Cummings, 1997). Overall, PGO has been associated with lower performance, relative to LGO (c.f., Bell & Kozlowski, 2002b). One reason could be that it has been shown to be positively related to task-related cognitive interference (Hofmann, 1993).

Initial hypotheses on LGO as compared to PGO were that trainees could not be simultaneously high or low on both orientations at the same time, thus measures for the two goal orientations tended to put the two orientations on a single dimension. When researchers questioned this assumption, they found that the choice of learning goals was not mutually exclusive and trainees could have multiple goals (Button, Mathieu, & Zajac, 1996). They also found that high PGO is not always a detriment. PGO is positively associated with performance, especially when LGO is also high (Elliot, 1997; Elliot & Church, 1997; Elliot & Harackiewicz, 1996). For example, when trainees were both high in LGO and low in PGO, they had higher levels of performance after practice; however, when they were high in both LGO and PGO, somewhat paradoxically, they had the lowest levels of performance after practice (Yeo & Neal, 2004).

More recently, the 2-goal model has been extended to include an approach-avoidance distinction. Approach goals are focused on positive outcomes and avoidance goals focused on avoiding negative outcomes. At first, only PGO was partitioned into separate approach goals, referred to as a prove performance orientation (PPO) in which trainees want to prove themselves by performing well and an avoid performance goal orientation (APGO) with trainees seeking to avoid mistakes (Elliot & Church, 1997; Elliot & Harackiewicz, 1996; VandeWalle, 1997). In this 3-goal model, LGO was considered to be only an approach goal. Research has shown that PPO is related to achievement in learning contexts when conceptualized as a goal to perform better than others, although it has been found to be unrelated to some adaptive variables such as deep processing (Elliot, McGregor & Gable, 1999; Harackiewicz, Barron, & Elliot, 1998; Harackiewicz Barron, Tauer, Carter, & Elliot, 2000) and intrinsic motivation (Church, Elliot, & Gable, 2001; Elliot & Church, 1997; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997; Tanaka & Yamauchi, 2001). In a review of the literature supporting the separation of PGO into PPO and APGO, Harackiewicz and colleagues found that LGO and PPO independently promoted different learning outcomes and found that optimal motivation occurred when trainees had adopted both goal orientations. APGO has, however, been found to be associated with many negative learning outcomes that PGO had before: higher anxiety, lower learning performance, and maladaptive behaviors after failure such as learned helplessness and self-handicapping (Barron & Harackiewicz, 2001; Elliot & Church, 1997).

Even more recently, a full 2×2 learning goal model was proposed in which LGO was divided in terms of approach and avoidance; approach LGO (ApLGO) was conceptualized as a focus on task mastery with avoidance LGO (AvLGO) a focus on not doing worse than before (Elliot & McGregor, 2001). Performance-approach goals correspond to positive learning strategies and learning outcomes and are unrelated to negative learning processes and outcomes, whereas performance-avoidance goals are more likely to be linked to a negative achievement pattern (Elliot & McGregor, 1999; Elliot & Moller, 2003). For example, ApLGO has been positively linked to the tendency to process information in depth and to the more frequent and effective use of metacognitive strategies and negatively to procrastination. In contrast, AvLGO was positively linked to the tendency to process information shallowly, and negatively associated with the use of metacognitive strategies and procrastination behaviors (Howell & Watson, 2007).

There have been several moderators of the high PGO-performance relationship. Individual differences may moderate the relationship between PGO and learning performance. For example, self-efficacy may improve the learning performance of high PGO trainees; trainees with a high PGO who also have high self-efficacy practiced more than trainees with a high PGO and low self-efficacy (Brown, 2001; DeRouin et al., 2005).

The complexity of the task can be important: High PGO trainees can outperform high LGO trainees when the learning task is relatively simple (Seijts, & Latham, 2001; Seijts, Latham, Tasa, & Latham, 2004; Winters & Latham, 1996), however, high PGO trainees did not perform as well as high LGO trainees when the task was complex (Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000). Cognitive resources are generally limited and when the task is difficult, specific performance goals should not be used in the early phases of learning a new task since such goals were found to require significant amounts of cognitive resources in complex tasks (Deshon & Alexander, 1996, Kanfer & Ackerman, 1989).

The fit between training conditions and trainee personalities and learning goal orientations can impact learning performance; individuals high in PGO increased their learning performance when the specificity of feedback was increased and the effects of feedback specificity was greatest for high-PGO trainees who were also low in LGO (Davis, Carson, Ammeter, & Treadway, 2005). Learning goals can also be influenced by instructions. People can be helped to discover needed strategies by assigning them difficult and specific learning goals instead of difficult and specific outcome goals (Seijts & Latham, 2001; Seijts et al., 2004; Winters & Latham, 1996). Self-esteem is often negatively related to avoidance goals while positively related to approach goals (Heimpel, Elliot, & Wood, 2006).

Need for Achievement

Need for Achievement includes characteristics like perseverance during challenge, strong work behavior, and desire for excellence. Mount and Barrick (1995) found in a meta-analysis that need for achievement was correlated with training proficiency. Hough (1998) found that need for achievement was related to job proficiency, training success, and educational success. Need for achievement has also been linked with training motivation (Carlson, Bozeman, Kacmar, Wright, & McMahan, 2000). Need for achievement is related to the constructs of ambition and achievement motivation. Not surprisingly, ambition has been shown to predict academic performance (Driskell, Hogan, Salas, & Hoskin, 1994). Students high in need for achievement are more likely to set challenging goals for their class performance and consequentially are more likely to obtain better grades (Hollenbeck, Williams, & Klein, 1989; Phillips & Gully, 1997). In Colquitt, LePine, and Noe's (2000) meta-analysis concerning training, it was found that achievement motivation was moderately linked to motivation to learn. Trainees high in need for achievement tended to endorse learning goals and were less likely to endorse performance avoidance learning goals (Payne et al, 2007).

Personal Control Beliefs

Personal control beliefs reflect individuals' beliefs regarding the extent to which they are able to control or influence events to receive a desired outcome (see Skinner, 1996 for a review). They are central concepts in several theories of motivation and self-regulation, including expectancy theory (Vroom, 1964), self-determination theory (Ryan & Deci, 2000), and social-cognitive theory (Bandura, 2001). Trainees will be more motivated to perform well in training if they believe that their efforts will lead to high quality training outcomes, that high performance in training will also lead to high job performance, and that high job performance will be instrumental in obtaining preferred outcomes while avoiding unwanted outcomes (Noe, 1986). Research on specific control beliefs is summarized below.

General Self-Efficacy (GSE) and Self-Esteem

Setting realistic goals and monitoring progress towards these goals involves self-efficacy, a belief that a person has the ability to organize and carry out the actions required to achieve one's goals (Bandura, 1997). Self-efficacy can be conceptualized as one's belief about performance capabilities in a particular domain or on a general belief of their performance capabilities across tasks (GSE). Self-efficacy beliefs are related to motivation to learn, learning performance, and job performance (Colquitt et al., 2000), as well as phenomena related to learning such as self-regulatory behavior (Malpass, O'Neil & Hocevar, 1999) and transfer of training (Gist et al., 1991). Self-esteem also mediates the relationship between goal orientation and performance; trainees high in performance goal orientation who also have high self-efficacy beliefs, practiced the most in an Internet training class while trainees who were high in performance orientation and had low self-efficacy beliefs, practiced the least (Brown, 2001). Self-efficacy has been shown to influence trainees' decision making during training. For instance, higher self-efficacy has been shown to be related to the more frequent and effective use of learning strategies (Schunk & Ertmer, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992). Training interventions directed at increasing trainees' task-specific self-efficacy were more effective among trainees with low, rather than high, GSE (Eden & Aviram, 1993; Eden & Zuk, 1995).

Self-esteem is an affective⁸ component of self-evaluation and is a belief of self-worth and liking or disliking. Research by Chen, Gully, and Eden (2004) suggests that GSE may be more strongly related to motivational mechanisms such as task specific self-efficacy, self-set goals, and effort allocation, whereas self-esteem is relatively more strongly related to emotional mechanisms, such as state anxiety and emotional regulation.

⁸ Affect refers to the experience of feelings or emotions. The affective domain represents one of the three divisions described in modern psychology: the cognitive, the conative, and the affective. The *cognitive* domain is closely related to abstract concepts such as mind, reasoning, perception, intelligence, learning, and information processing. The *conative* domain includes processes such as impulse, desire, volition, and striving. The *affective* domain includes motives, attitudes, moods, and emotions.

Locus of Control

Locus of control (LOC) is a generalized belief about one's personal efficacy. It refers to the extent to which individuals believe that they can control events that affect them. Individuals with an internal LOC tend to believe that performance outcomes are contingent on their own behaviors and individuals with external LOC tend to believe that performance outcomes are more situational and beyond their control (Rotter, 1966). Those with extreme external LOC often believe that powerful others, fate, or chance primarily determine events. Trainees with greater internal LOC have more positive attitudes toward training (Noe & Schmitt, 1986) and have higher self-efficacy beliefs (Phillips & Gully, 1997). Internal LOC has been found to be more related to skill acquisition than to external LOC (Silver, Mitchell, & Gist, 1995). Internal LOC was more strongly related to motivation to learn, whereas external LOC was moderately related to declarative knowledge and transfer of training (Colquitt et al., 2000). However, internal LOC is trainable; for instance, computer-based instruction can facilitate a perception of internalization of control, especially with disadvantaged learners (Swan, Mitrani, Guerrero, Cheung, & Schoener, 1990). Of special interest to this literature review, research has shown that individuals with internal LOC tend to significantly outperform external LOC individuals in computer-based training (Santiago & Okey, 1992; Wang & Newlin, 2000).

Instrumentality

Instrumentality is the belief that higher training performance will result in rewarding outcomes. Unfortunately, although much research has been conducted to confirm the influence of instrumentality on motivation in general, little research has examined the effect of instrumentality beliefs on training outcomes. In one study, Mathieu, Tannenbaum, and Salas (1992) found no relationship between instrumentality beliefs and performance in a training class, but thought that the topic (how to proofread) may not have been perceived as instrumental to a successful career in clerical and administrative assistant positions. However, a second study by Chiaburua and Lindsay (2008) found that instrumentality was a crucial indicator of both motivation to learn and transfer of training. The conflicting results leave the value of instrumentality uncertain.

Learning Styles

The term "learning styles" (also known as cognitive styles) refers to the concept that people differ with regard to what mode of instruction or study is most effective for them. Advocates of learning-style assessment contend that ideal instruction requires identifying an individual's learning style and tailoring instruction to the learning style. Assessments of learning style typically ask people the sort of information presentation they prefer (e.g., words versus pictures) and what type of mental activity they find most engaging. The learning-styles perspective has acquired great sway with educators and trainers ranging from kindergarten to graduate school practitioners. The followers of specific learning style theories (e.g., Kolb, 1984) are often enthusiastic devotees. There is a thriving industry publishing learning-styles instruments and guidebooks, as well as

providing professional development workshops on specific learning-styles for trainers, teachers, and educators.

Currently, research supporting learning styles is controversial. Coffield, Moseley, Hall, & Ecclestone (2004) conducted an extensive review of the research literature funded by the Department for Education and Skills, United Kingdom. In the review, they identified 71 different theories of learning styles and closely reviewed the 13 most popular theories, concluding that none had been adequately validated through independent research (either failing to meet standards for either construct validity or predictive validity and, not infrequently, both) and most of the associated measures had at least one psychometric weaknesses (internal consistency or test-retest reliability). A more recent review of the learning styles literature was conducted by Pashler, McDaniel, Rohrer, and Bjork (2009). The authors were charged with determining whether learning-styles instruments, practices, and theories were supported by scientific evidence. They found many problems with the research designs and resulting validation evidence for learning style theories. They found most of the evidence they collected showed training methods were equivalent across different styles and, where there was evidence to support learning styles, the evidence was weak and often conflicting. Therefore they concluded that it was not meaningful or cost-effective to conduct assessments or to develop training specific to different learning-styles.

Personality Traits

Big Five Personality Traits

The Big Five model is a comprehensive, data-driven research model of personality. The Big-Five model (also referred to as the Five Factor Model, or FFM) was created by factor analyzing numerous personality trait measures; this model was discovered independently by several researchers looking for a taxonomy of personality traits (e.g., Digman, 1990; Goldberg, 1990). The model is comprised of five higher-order traits that are each composed by several lower-level, narrower, and more specific facets. The predictability of the five personality traits have been found to be both broad and comprehensive, and as would be expected, some of the lower-level facets are more predictive than the broader level traits in some situations.

The five factors are extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience (also referred to as intellectance; e.g., McCrae & Costa, 1992). People who score high on extraversion tend to have positive emotions, be assertive, and have the tendency to seek out stimulation and the company of others. People who are agreeable tend to get along with other people. They tend to feel compassionate and cooperative towards others instead of suspicious or antagonistic. Conscientious people are self-disciplined, follow rules, and they tend to be goal-driven. Neuroticism refers to the frequency to which people experience negative emotions. People who are neurotic are emotionally unstable, with their feelings changing more frequently compared to non-neurotic individuals. People who are open to experience are imaginative, curious, enjoy culture and abstract ideas, and are more sensitive to beauty. They tend to be more aware of their feelings and hold more unconventional beliefs. They also tend to seek out

and enjoy new ideas and situations and are more likely to change their beliefs after doing so.

In Barrick and Mount's (1991) meta-analysis, extroversion, conscientiousness, and openness to experience were all positively related to better training performance while emotional stability and agreeableness all had smaller results. However, another meta-analysis showed that while conscientiousness was positively related to motivation to learn it was negatively related to actual training performance (Colquitt et al., 2000). Several possible explanations exist for the mixed results for conscientiousness. While several of the facets of the conscientiousness trait generally reflect behavioral tendencies characteristic of successful self-regulation (Roberts, Chernyshenko, Stark, & Goldberg, 2005), some facets, (e.g., dependability, order, and dutifulness) have been shown to reduce performance when adaptability to changing task conditions is important (LePine, Colquitt, & Erez, 2000). Martocchio and Judge (1997) found that conscientiousness was positively related to self-deception in training settings, with trainees higher in conscientiousness tending to overestimate their level of learning, which was then negatively related to learning outcomes. Conscientiousness can mean that fewer tasks are getting done, since conscientious trainees take longer to complete a given set of tasks (Driskell et al., 1994). Conscientiousness also interacts with previous performance and with emotional stability to explain performance; when early performance is weak, higher conscientiousness has the greatest effect on learning performance, compared to trainees with higher conscientiousness that performed well early on (Herold, Davis, Fedor, & Parsons, 2002).

Higher anxiety levels have been associated with lower learning performance outcomes (Chen et al., 2000; Martocchio, 1994; Colquitt et al., 2000), and trainees who have higher state anxiety or who have higher emotional instability (i.e., neuroticism) show performance deficits in training. However, context can negate the performance deficit shown by anxious students; they perform better when given more structured learning environments but perform less effectively with relatively unstructured training (Snow, 1989, 1991). Kanfer and associates theorize that anxiety affects performance by diverting attentional focus, thus reducing resources available for relevant "on-task" learning (Kanfer & Ackerman, 1991; Kanfer & Heggstad, 1997). However, there is evidence that showing trainees how to handle errors does lead to better emotional control and higher learning performance. When error management training is provided, it can lower state anxiety and improve self-efficacy as well as performance (Bell & Kozlowski, 2008). Trainees who have instruction on how to manage learning errors show evidence of having acquired greater emotional control and metacognitive skills and will then outperform those who have not had error management training (Keith & Frese, 2005). Neuroticism was shown to be positively related to avoidance goals in general and negatively associated with approach goals, while extraversion was related to neither type of goal (Heimpel et al., 2006).

Emotional Intelligence

Goleman (1995) defined emotional intelligence⁹ (EI) as “the capacity for recognizing our own feelings and those of others, for motivating ourselves, and for managing emotions well in ourselves and in our relationship.” He described five dimensions: three are personal competencies (self-awareness, self-regulation, and a motivational competency) and two are social competencies (empathy and social skills) (Goleman, 1998). Although there is controversy over EI (c.f., Cote & Miners, 2006; Fox & Spector, 2000; Locke, 2005; Schulte, Ree, & Carretta, 2004), there is also evidence that EI is both distinct from other ability and personality measures and related to learning performance (Austin, Evans, Goldwater, & Potter, 2005; Law, Wong, & Song, 2004; Petrides, Fredrickson, & Furnham, 2004). For instance, for first year medical students, EI was positively related to attitudes about training and on exam performance early in the year, but not later in the year (Petrides et al., 2004). Nevertheless, there are many controversies concerning the structure, measurement, and stability of EI so that it has not been broadly studied in educational settings.

Tolerance for Ambiguity

Tolerance for ambiguity is related to how individuals react to uncertain situations or stimuli. The person with low ambiguity tolerance tends to perceive ambiguous stimuli as threatening and stressful, and tends to react prematurely to avoid ambiguity, while a person with high tolerance for ambiguity perceives the same stimuli as interesting and challenging (Furnham & Ribchester, 1995). When trainees encounter new concepts and ideas, they often do not understand all the new information, concepts sometimes appear to have multiple meanings and are vague (Chapelle & Roberts, 1986; Grace, 1998). There is also a tendency for those low in tolerance of ambiguity to perceive ambiguous situations rigidly in “black or white” terms (Bhushan & Amal, 1986). Students who are tolerant of ambiguity are more willing to take risks (Naiman, Frohlich, Stern, & Todesco, 1978; Rubin, 1975; Stern, 1975;) and show endurance on tasks, and have higher levels of achievement (Chapelle & Roberts, 1986; Naiman, Frohlich, & Todesco, 1975). Tolerance for ambiguity is also positively related to the academic success of undergraduates (Boyd, Hunt, Kandell, & Lucas, 2003). Students who have a tolerance for ambiguity are more likely to be high in LGO and lower in PGO (Kroll, 1988).

⁹ Goleman receives the popular credit for the term “emotional intelligence” because of his bestselling book. However, in the 1920s E. L. Thorndike used the term “social intelligence” in a similar way. In 1983, Howard Gardner's *Frames of Mind: The Theory of Multiple Intelligences* introduced Interpersonal Intelligence (understanding the motivations of other people) and Intrapersonal Intelligence (understanding your own motivations). Stanley Greenspan also used the term “emotional intelligence” in 1989 in his book *The Development of the Ego: Implications for Personality Theory, Psychopathology, and the Psychotherapeutic Process*.

Adaptability/Flexibility

Individuals who are adaptable or flexible are more willing to change approaches to tasks, enjoy variety, and are able to handle multiple demands. Adaptability is related to overall training outcomes (White et al., 2002). Carlson, Bozeman, Kacmar, Wright, and McMahan (2000) found adaptability was positively correlated with motivation to learn and reactions to training (see also, Stone, Kemmerer, & Guetal, 1984). While, in the literature, the definition of the construct varies somewhat, Houston, Borman, Farmer, and Bearden (2006) theorized that adaptability was essential to success in the Navy because of the constantly changing nature of jobs and evolving technologies used on those jobs. For example, Herold, Davis, Fedor, and Parsons (2002) highlighted that training programs, like the pilot training program they studied, are multifaceted, with different stages and different environments (e.g., classroom, simulator, aircraft with instructor). At each level, the individual characteristics, both cognitive and non-cognitive, interact and produce different results. However, adaptability was not related to academic performance at different time points, but was negatively related to rate of academic growth over time. Low adaptability students had more difficulty at the beginning of their education when there is the greatest amount of change and novel experiences, but they improved later in training. In contrast, high adaptability students adapted more quickly early in training, but had little room for improvement later in training (Shivpuri, Schmitt, Oswald, & Kim, 2006). While the low adaptive students were able to struggle through pilot training, there are few training pipelines that are two or more years in length. For a more typical (enlisted) training pipeline of 7–8 weeks, adaptability would be even more important since there is little time to recover from early difficulties.

Perceptiveness/Depth of Thought

Perceptiveness/Depth of Thought is defined as being interested in abstract thinking, in knowledge outside of one's specialty, and in understanding how things work. Perceptiveness/Depth of Thought has been correlated with educational success (Hough, 1992, 1998). The construct is related to openness to experience or intellectance.

Cognitive Playfulness

Cognitive playfulness is the tendency to “play” with new information or a problem by testing ideas and reviewing hypotheses (Csikszentmihalyi, 1990) and has been used in research predominantly in the context of human-computer interactions. Martocchio and Webster (1992) have found that cognitive playfulness is associated with learning performance and positive affect in CBT and that trainees low in playfulness benefit more from positive feedback compared to trainees high in cognitive playfulness (Martocchio & Webster, 1992; Webster & Martocchio, 1992). While interesting, this construct is not well researched and statistical relationships with a broad range of training or educational outcomes have not been established.

Emotional Control

Emotional control (also known as self-control) is the ability to suppress negative emotions and inappropriate behaviors, even in situations where it is difficult to do so, and to think before acting. Emotional control was found to have a small nonlinear relationship to academic performance at 2- and 4-year institutions over- and under-inhibition of strong feelings being detrimental to a student's ability to perform academically (Robbins, Allen, Casillas, Peterson, & Le, 2006). They also found that the relationship between emotional control and retention was stronger and it was found to be a stronger predictor than academic self-confidence.

Emotional control can be trained. Trainees who received instructions to use an emotion-control strategy designed to increase the frequency of positive thoughts and reduce the frequency of negative thoughts had better training performance (Kanfer & Ackerman, 1989). Error management instructions can improve trainees' ability to handle negative emotions (Bell & Kozlowski, 2008; Keith & Frese, 2005), which then improves transfer of training (Keith & Frese, 2005).

Positive and Negative Affect

Affective disposition is the tendency for an individual to have emotional responses that tend to follow a pattern across time and situations. Measured as an individual trait, positive affect denotes an individual with high energy who tends to experience positive moods, while negative affectivity is characterized by an individual who tends to be more in distress and experience negative moods (Watson, Clark, & Tellegen, 1988). People who tend to experience positive affect tend to have judgments that are more positive and give feedback that is more favorable because they interpret situations more positively and more optimistically than people who tend not to experience positive affect (Isen & Patrick, 1983; Petty, Schumann, Richman, & Strathman, 1993; Weiss, Nicholas, & Daus, 1999), suggesting that positive affect may be related to reactions to training. Positive affect has a facilitative effect on intrinsic motivation by influencing the cognitive process involved in motivation, namely the evaluation of the rewards and beliefs about self-efficacy and instrumentality (Erez & Isen, 2002; Isen & Reeve, 2005). Therefore, positive affect may increase intrinsic motivation during training. While positive and negative affect state measures have been used in training studies (e.g., Bretz & Thompson, 1992), to date trait measures have not.

Creativity

Most research looking at training and creativity focuses on the trainability of creativity (e. g., Scott, Leritz, & Mumford, 2004) or how training contributes to creativity (e. g., Weisberg, 1999). There have been a few early studies that suggest creative thinking contributes to academic achievement (Feldhusen, Treffinger, van Mondfrans, & Ferris, 1971; Yamamoto, 1964), but that line of research ended and no study to date has examined if creativity would improve training outcomes in organizations. LGO has recently been associated with creative performance (Gong, Huang, & Farh, 2009; Hirsch, G., van Knippenberg, & Zhou, 2009). Generally speaking,

there is no agreement on how to measure creativity broadly which has limited the amount and consistency of research.

Job-Knowledge and Work Experience

Previous knowledge of a topic has a strong positive effect on training performance, predicting both the rate of learning and the amount learned (Schmidt, Hunter, & Outerbridge, 1986). Trainees with previous knowledge tend to use advanced strategies during learning, while trainees with less knowledge tend to approach learning by initially developing a conceptual framework of the domain (Alexander, Jetton, & Kulikowich, 1995; Murphy & Alexander, 2002). Prior domain knowledge was positively related to monitoring and planning activities and negatively related to the use of strategies during a hypermedia CBT activity (Moos & Azevedo, 2008). Trainees with lower prior domain knowledge, in general, tended to use less varied strategies during learning (Alexander et al., 1995; Murphy & Alexander, 2002). In essence, prior experience allows the early adoption of a good strategy (with self-monitoring to ensure it is working) whereas a lack of prior experience leads to strategy switching but the changes are among a small set of “logical” approaches. At least part of the difficulty some trainees have in navigating in hypermedia training activities has been found to be related to a limited understanding of the conceptual structure of the domain that would otherwise help to guide their interaction with hypermedia (Chen, Fan, & Macredie, 2006; Shapiro, 2004). Previous experience with information helps trainees be more efficient in their use of training materials (Shih, Muñoz, & Sánchez, 2006) but its’ effect fades by the end of training (Ree, Carretta, & Teachout, 1995; Shih, Muñoz, & Sánchez, 2006).

Aptitudes

The benefits of including intellectual measures in decisions about selection and training assignments are undeniable (Gottfredson, 1986). The benefits for the organization include reduced training failures and training costs and greater performance and productivity (Hunter, 1983). For the individual, the benefits include a greater probability of success (in training and on-the-job) and a better match between their abilities and their training and job assignments (Ones & Viswesvaran, 2002). The mechanism for the success of assignments based on intellectual ability is well understood; the training and job characteristics tap many of the same intellectual abilities used to perform the tasks (Hunter & Hunter, 1984).

In enlisted military selection and classification, the Armed Services Vocational Aptitude Battery (ASVAB) provides the intellectual assessment. The ASVAB is a 9-test multiple-aptitude battery that has been used to predict success in training in the Navy (Driskell et al., 1994; Wolfe, Moreno, & Segall, 2004), the Air Force (Besetsny, Earles, & Ree, 1993; Earles & Ree, 1992), the Army (Campbell, 1990), and for civilian (and military) air traffic controllers (Carretta & King, 2008). Ackerman and associates have found that the ASVAB tests can predict learning performance (Ackerman, 2003). Job-specific aptitudes such as table reading, technical reading, industrial math, and following directions (all prior ASVAB tests) were associated with task performance of

apprentices on manufacturing tasks (Hatstrup & Schmidt, 1990). However, since ASVAB scores are used to make assignments of recruited Sailors to ratings, and hence to training, range-restriction may appear to limit the ability of ASVAB tests to predict training success after assignment has been made, although statistical corrections can ameliorate this. In the Navy, the validity of the ASVAB to predict training outcomes varies from about 0.30 (special operations) to as high as 0.85 (Nuclear Field). While these training outcome validities are very good for any intellectual ability measure, there is substantial evidence that the predictions can be improved by including non-cognitive measures (e.g., Campbell, 1990).

Work-related Attitudes

An attitude is a long-lasting evaluation of a specific person, a group of people, or objects. Attitudes have an emotional aspect (degree of like or dislike of the object in question), a behavioral aspect (how you behave toward the object), and a cognitive aspect (beliefs about the object), and most attitudes are learned responses (Fazio, 1986).

Organizational Commitment

Mowday, Porter, and Steers (1982) defined organizational commitment as the “relative strength of an individual’s identification with and involvement in a particular organization” (Mowday, Porter, & Steers, 1982, p. 27; for more contemporary views, see Meyer & Allen, 1991, 1997). The more committed trainees are to the organization, the more likely they are to view training as useful for themselves and the organization (Colquitt et al., 2000). Organizational commitment is positively related to motivation to learn, transfer of learning, and to reactions to training (Fecteau, Dobbins, Russell, Ladd, & Kudisch, 1995; Tannenbaum et al., 1991), although at least one study did not find such a relationship (Carlson et al., 2000). Gade (2003) provides extensive evidence on the importance of organizational commitment in the military in terms of retention, attrition, training and job performance.

Organizational Justice

Organizational justice research explores how perceptions of fairness are related to organizational outcomes (Greenberg, 1990). Perceptions of fairness strongly affect the employees’ attitudes, including job satisfaction, turnover intentions, organizational commitment, and workplace behavior such as job satisfaction, evaluation of authority, citizenship behavior, withdrawal cognitions, and job performance (Colquitt, Conlon, Wesson, Porter, & Ng, 2001). Research has found four distinct types of fairness perceptions: distributive, procedural, interpersonal, and informational justice (Colquitt, 2001). Distributive justice, the fairness of the rewards and outcomes received, is generally perceived if rewards received are proportional to perceived input (Adams & Jex, 1999). Procedural justice refers to the fairness of the procedures used in making decisions about rewards (Leventhal, 1980). The interpersonal treatment people receive as procedures are followed is interactional justice (Bies & Moag, 1986), while the fairness and adequacy of explanations of the procedures and decisions is called

informational justice (Greenberg, 1993). Only two studies have linked fairness perceptions to training outcomes. Quiñones (1995) found that a combined measure of distributional and procedural fairness of training assignment was positively related to motivation to learn. Liao and Tai (2006) found that interactional justice mediated the relationships between distributive and procedural justice and motivation to learn.

Attitudes Towards Training

Similar in concept to affective and cognitive reaction measures of training, attitudes towards training are beliefs held towards the training program but measured before training begins. The reputation of the quality of the training program has been linked to training motivation (Fecteau et al., 1995). Having a positive attitude towards formal training in general has also been associated with increased training motivation (Carlson et al., 2000). Self-efficacy and motivation to learn is affected by trainees' expectations about the training program (Tannenbaum et al., 1991), suggesting that trainees' expectations about training developed before training takes place should be considered.

Discussion

Based upon this review of the literature, the case can be made to include the following measures of individual differences:

- Motivation to learn, preferably before actual training
- Intrinsic motivation
- Metacognitive abilities, including self-reflection
- Goal orientation, specifically measures from the goal orientation model
- Control beliefs (self-efficacy, locus of control)
- Personality (Big Five and lower-level facets of conscientiousness; flexibility, self-control, emotional control)
- Organizational commitment and perceptions of fairness
- Attitudes towards training (met expectations)

There are many published and commercial tests available that could be used to assess these constructs. Unfortunately, test administration and scoring could be very costly and since many of the measures are proprietary, the cost for using them would be in perpetuity if the Navy continued their use. However, many of these measures can be found in a battery of individual difference measures developed by Navy Personnel Research, Studies, and Technology (NPRST) and funded by the Office of Naval Research (ONR). The battery of 19 traits is called the Navy Computer Adaptive Personality Scales (NCAPS). This battery is owned by Navy and would entail no use or scoring costs.

NCAPS was created to be complementary to the Armed Forces Vocational Aptitude Battery (ASVAB) used to assign all military recruits to enlisted jobs based on technical knowledge and intellectual ability. NCAPS was designed to predict a wide-range of training and job performance outcomes as well as important aspects of organizational behavior (e.g., commitment, integrity, leadership). Based on an extensive review of the research literature, functional knowledge of the Navy, and subject matter expert judgments (Borman, Hedge, Ferstl, & Kaufman, 2002; Borman, Hedge, Ferstl, Kaufman, Farmer, & Bearden, 2003; Ferstl et al., 2003), NCAPS is composed of traits relevant to performance in each Navy enlisted rating and most officer designators as well. NCAPS has been further refined based on psychometric testing, expert evaluations, and extensive field studies.¹⁰ Below is the list of NCAPS trait measures; descriptions of the attributes of high and low scores for each scale are supplied in Appendix A.

- Achievement (AV)
- Adaptability/Flexibility (ADF)
- Attention to Detail (ADL)
- Dependability (DEP)
- Dutifulness/Integrity (DUT)
- Self-Reliance (SRL)
- Social Orientation (SO)
- Stress Tolerance (ST)
- Vigilance (VIG)
- Willingness to Learn (WTL)
- Leadership Orientation (LO)
- Self-Control (SC)
- Perceptiveness/Depth of Thought (PDT)
- Innovation (INV)
- Initiative (INI)
- Empathy (EMP)
- Commitment (COM)
- Positive Self-Concept (PSC)
- Tolerance for Ambiguity (TA)

¹⁰ Note that NCAPS concept and design won the prestigious M. Scott Myers Award from the Society for Industrial and Organizational Psychology for “Innovative talent measurement and recognized for contributions to applied research in the workplace” (January 14, 2010, Atlanta, GA).

NCAPS has been shown to be psychometrically sound (Schneider et al., 2006). Studies have found that the NCAPS traits correlate significantly with similar traits in commercial and published measures. Initial validation studies have demonstrated NCAPS' ability to predict learning performance in university classes (Underhill, 2006) and Navy training at multiple Learning Centers (Houston, Borman, Farmer, & Bearden, 2006) with initial results being very promising especially for ratings with high attrition rates such as Air Traffic Controllers, Explosive Ordnance Disposal-Diver, and Basic Underwater Demolition/SEAL (BUD/S) training (Houston et al., 2006; Rice & Mottern, 2008). A fleet pilot study demonstrated that NCAPS traits correlated with supervisors' performance ratings (using behaviorally anchored rating scales) across a variety of Navy enlisted ratings (Schneider et al., 2006).

NCAPS has the added benefit of being web-enabled, uses items presented in a paired-comparison format, which is scored using Item Response Theory (IRT), and is administered as a computer adaptive instrument. NCAPS uses a paired-comparison item presentation format that is considered more difficult to "fake good"¹¹ than standard Likert¹² scales. The test is scored using a modified Zinnes and Griggs ideal point paired-comparison IRT model (Stark, Chernyshenko, & Drasgow, 2006; Stark & Drasgow, 2002; Underhill, 2006) which dramatically reduces the number of items necessary to reliably measure a trait. In addition, the test is adaptive in that items are statistically selected based on the answer to previous questions. Finally, the 19 traits are not measured in cohesive blocks of items (e.g., all the integrity items, followed by all the self-control items). Rather, trait items are randomly intermixed which further increases the difficulty of faking. Several experiments have been conducted that demonstrate NCAPS to be resistant to faking and socially desirable responding (Underhill, Bearden, & Chen, 2008).

The combination of NCAPS coverage of critical individual difference constructs found in the review, Navy ownership of the test, demonstrated value for predicting Navy relevant outcomes including training, careful design characteristics, and contemporary administration all argue strongly for including NCAPS in evaluations of computer-based training and job performance outcomes. NCAPS will need to be augmented with specific training measures to obtain the full spectrum of important factors that affect these outcomes.

¹¹ This is the term used when describing people trying to answer questions (fake) to impress others, particularly when applying for jobs.

¹² Likert scales are traditional unidimensional point scales varying across a continuum, e.g., from "strongly disagree" to neutral to "strongly agree" where the respondent's task is to rate (usually themselves) about a question (e.g., I work harder than my coworkers).

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Appendix A:
NCAPS Scales and Descriptions of the Attributes of High
and Low Scores

Table A-1
NCAPS scales and descriptions of the attributes of high and low scores

Scales	High Scores	Low Scores
Achievement (AV)	Like to set challenging goals; work hard over long periods of time when necessary to achieve goals; persists in the face of significant obstacles that would cause others to give up; strives for excellence; confident in ability to perform well.	Avoid challenging goals and projects; prefer to work only as hard as necessary to complete projects and tasks; gives up easily when confronted with obstacles; doubt their ability to perform well; display little ambition.
Adaptability and Flexibility (ADF)	Are willing to change their approach to tasks and projects; like considerable variety at work; adapt readily to changes in their environment involving additional constraints, multiple demands, and unanticipated adversity.	Like to do things the way they always do them; have difficulty adjusting to new people, situations, and environments; do not adapt well to changes in their environment involving additional constraints, multiple demands, or unanticipated adversity.
Attention to Detail (ADL)	Are exacting, precise, and accurate; spot minor imperfections or errors; are meticulous and thorough in their approach to tasks.	Are sloppy and imprecise; miss important details; make careless errors.
Dependability (DEP)	Are reliable, well organized, orderly and planful; use their time efficiently; prioritize tasks; stay on schedule; are not easily distracted or bored by routine tasks; do not procrastinate, even when tasks are unpleasant or unexciting.	Are unreliable; fall behind in assignments or duties; miss deadlines; put off unpleasant tasks and are easily distracted while working them; rarely plan before starting a task; often lose things.
Dutifulness and Integrity (DUT)	Have a strong sense of duty and moral obligation; try to do what is right and ethical; accepts authority and follows rules and regulations; fulfill their obligations and commitments; accept the consequences of their actions.	Are rebellious and contemptuous of rules and regulations; refuse to be held accountable for their own actions; are undisciplined and self-indulgent; cannot be trusted and break promises.

Table A-1
NCAPS scales and descriptions of the attributes of high and low scores

Scales	High Scores	Low Scores
Self-Reliance (SRL)	Are self-sufficient, resourceful, and like to make their own decisions; avoid becoming dependent on others to get things done.	Frequently rely on others to get things done; easily become dependent on others for reassurance; may feel insecure without support; often take up excessive time of receptive listeners seeking support.
Social Orientation (SO)	Like to work with others rather than alone; like and accept people readily; are sensitive to others' needs and feelings; are understanding and helpful; increase cohesiveness in groups in which they participate.	Are shy, reserved and aloof; prefer to be alone; are insensitive to others' feelings; are critical and generally unaccepting of others; create friction when others are around.
Stress Tolerance (ST)	Maintains composure and retain ability to think clearly and take effective action when confronted with stressful situations; can readily put aside worries and feelings of guilt; accept criticism without becoming upset.	Becomes indecisive or make poor decisions in times of stress due to loss of composure; are prone to feelings of worry, guilt, and vulnerability; are easily upset; tend to ruminate about troubling events and perceived failures; do not take criticism well.
Vigilance (VIG)	Are able to constantly scan the environment for things that require attention, even when no action is required for long periods of time.	Over long periods of time, experience lapses in attention when required to scan the environment for low frequency but critical actions or events.
Willingness to Learn (WTL)	Demonstrates a willingness to learn new material in classroom or on the job and apply that material to new work situations; learns from mistakes, asks questions when needed and takes advice; actively seeks out learning opportunities.	Avoids training opportunities; doesn't apply new knowledge to work situations; doesn't learn from mistakes or others advice; have a narrow range of interests.

Table A-1
NCAPS scales and descriptions of the attributes of high and low scores

Scales	High Scores	Low Scores
Leadership Orientation (LO)	Are willing to lead, take charge, offer opinions and direction, and take responsibility for guiding others' actions; assume the role of leader when no one else steps forward; are able to mobilize others to act; are confident, forceful, firm, and decisive.	Are unwilling to offer opinions and direction; will not step forward to lead when no one else will; unable to mobilize others into action; does not appear to others as decisive, confident, forceful, or firm.
Self-Control (SC)	Plans actions when new challenges arise; always think thorough possible consequences when speaking; doesn't vent emotions to others.	Tends to act on the "spur of the moment;" speaks out and vents emotions without thinking through possible consequences.
Perceptiveness and Depth of Thought (PDT)	Interested in pursuing topics in depth; enjoys abstract thought; seeks to understand the "big picture;" seeks knowledge outside of own specialty; needs to understand how things work and the underlying causes of a problem.	Doesn't seek knowledge outside of personal area of responsibility; needs to operate in concrete terms; not interested in understanding the underlying causes of problems.
Innovation (INV)	Are able to come up with new ideas for, and answers to, work-related problems; does not stick to old approaches simply because things have always been done that way; looks at old things in new ways; are open to new ideas and alternate ways of thinking; are inventive and imaginative.	Likes to stick to establish methods rather than experimenting with new approaches; have little or no desire to innovate or think creatively; become impatient when others seek to brainstorm new ideas or approaches.
Initiative (INI)	Takes action at one's own discretion; willing to take on responsibilities and challenges; persists in the face of obstacles and overcomes barriers; volunteers for tasks outside of regular duties.	Unable to take action on one's own; avoids taking on responsibilities and challenges; often gives up in the face of obstacles, cannot overcome barriers; rarely volunteers for tasks outside of regular duties.

Table A-1
NCAPS scales and descriptions of the attributes of high and low scores

Scales	High Scores	Low Scores
Empathy (EMP)	Recognizes and understands other's states of mind or emotions; demonstrates compassion towards others; takes care of others in need; provides sympathy and comfort; helps others.	Seldom recognizes or understands other's states of mind or emotions; avoids situations where they may need to comfort others in need; fails to demonstrate compassion toward others; unsympathetic towards others.
Commitment (COM)	Is psychologically and emotionally attached to the Navy; identifies with, is involved in, and enjoys being in the Navy; views own values as congruent with Navy values; feels a sense of obligation toward the Navy; believes that staying in the Navy is the right thing to do.	Is not psychologically and emotionally attached to the Navy; doesn't identify with, is not involved in, and doesn't enjoy being in the Navy; views own values as incongruent with Navy values; feels no sense of obligation toward the Navy; believes that staying in the Navy is the wrong thing to do.
Positive Self-Concept (PSC)	Positively evaluates self; confident in own competence and capabilities; believes outcomes are determined by one's own behavior rather than luck or fate; optimistic, enthusiastic, and cheerful.	Negatively evaluates self; not confident in own competence and capabilities; believes outcomes are determined by luck or fate rather than one's own behavior; pessimistic, lacks enthusiasm, and cheerless.
Tolerance for Ambiguity (TA)	Handles uncertain and unstructured situations effectively and with confidence; prefers unpredictable work environments in which the problems (and potential solutions) are ill-defined.	Cannot handle uncertain and unstructured situations effectively and with confidence; prefers predictable work environments in which the problems (and potential solutions) are well-defined.

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